HIGH FREQUENCY EFFECTS AND PERFORMANCE OF A 600 GHz - 635 GHz S1S RECEIVER USING Nb/AlOx/Nb JUNCTIONS.

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The importance for radioastronomy of molecular rotational lines at submillimeter wavelengths has led to the development of sensitive heterodyne receivers. Superconducting S1S mixers using all-niobium junctions are expected to work well at frequencies up to the energy gap frequency near 700 GHz (and possibly even twice this frequency with some degraded performance). We will present the performance of a waveguide, S1S heterodyne receiver in the frequency range 600 GHz - 635 GHz. The mixer employs single 0.25-μm^2 $Nb/AlO_x/Nb$ junctions coupled to wideband Nb/SiO/Nb microstrip tuning structures. We have measured double sideband receiver noise temperatures as low as 245 K ± 15 K at 600 GHz -610 GHz, and close to 300 K over most of the tunable bandwidth, presently limited by the LO source range. This receiver has been used for astronomical observations at the Caltech Submillimeter Observatory in Hawaii.

These results demonstrate that S1S mixers can operate as expected at signal frequencies very near the gap frequency of niobium, However, the optimization of the mixer at such frequencies is limited by the overlap of the second-order photon step from the negative voltage region onto the first-order photon step where the junction is biased. This overlap is observed as a current drop in the current-voltage characteristics, and as a sharp dip in the IF output power for the voltage $V = 2\ h\omega/e - Vg$. We have systematically studied the effect on receiver performance and measured a noise increase of up to 40% in the region where the photon steps overlap. We will present a comparison of these experimental results with theoretical calculations using Tucker's theory. In addition, near 630 GHz, the bias range for best performance is restricted to only the vicinity of the second Shapiro step, hence requiring full cancellation of the AC Josephson effect by an external field.

This research was performed by the Center for Space Microelectronics Technology, Jet Propulsion Laboratory, California Institute of Technology, and was jointly sponsored by the National Aeronautics and Space Administration / Office of Advanced Concepts and Technology and the Office of Space Science, and the Innovative Science and Technology Office of the Ballistic Missile Defense Organization.

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